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Maximization of fructose esters synthesis by response surface methodology

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Enzymatic synthesis of fructose fatty acid ester was performed in organic solvent media, using a purified lipase from *Candida antartica* B immobilized in acrylic resin. Response surface methodology with a central composite rotatable design based on five levels was implemented to optimize three experimental operating conditions (temperature, agitation and reaction time). A statistical significant cubic model was established. Temperature and reaction time were found to be the most significant parameters. The optimum operational conditions for maximizing the synthesis of fructose esters were 57.1°C, 100 rpm and 37.8 h. The model was validated in the identified optimal conditions to check its adequacy and accuracy, and an experimental esterification percentage of 88.4% (±0.3%) was obtained. These results showed that an improvement of the enzymatic synthesis of fructose esters was obtained under the optimized conditions.

Introduction

Sugar esters are non-ionic biosurfactants that consist of a carbohydrate moiety as hydrophilic group and one or more fatty acids as lipophilic component(s). By controlling the esterification degree and the nature of fatty acid and sugar, it is possible to synthesize sugar esters within a wide range of properties.

An increasing interest in the production of sugar esters has been reported, because they can be used as surface-active components in many industrial fields, as cosmetics, health-care, pharmaceuticals and food industries [1,2]. Furthermore, these compounds have certain advantages over synthetic surfactants, such as being prepared from renewable sources; tasteless, odorless, stable over a broad pH range and non-irritant. In food industry, fructose esters can be used in the production of aromas and maturation of cheeses, bakery products, cakes and biscuits, mayonnaise and sauces, instant products and sausages, among others [3]. In addition, sugar ester properties as antibiotics [4], anti-tumor agents [5] and insecticides [6] are well reported and might open new markets. For the past few years, several researchers have investigated the lipase-catalyzed synthesis of sugar containing acrylic esters for their biomedical applicability [7–9]. Moreover, these compounds are biodegradable, biocompatible and essentially non-toxic [10,11].

Sugar esters can be synthesized either by chemical or enzymatic processes. Chemical production of sucrose esters is usually base-catalyzed at high temperatures, has a low selectivity, forming colored derivatives as side-products [1]. Enzymes have been successfully applied to the regioselective transformations of mono- and oligosaccharides, including acylation, deacylation and oxidation reactions. The enzyme-catalyzed synthesis of sugar esters provides regio- and stereoselective products [12–14]. Previously, sugar esters were synthesized mostly by esterification in aqueous media causing hydrolytic side reactions. To prevent these side reactions, solvents such as pyridine and dimethylformamide were used as reaction media [15]. However, the solubility of sugars and the activity of enzyme were decreased due to the increased hydrophobicity introduced by these organic solvents in the reaction system. In addition, the use of sugar esters as food additives and pharmaceuticals was incompatible with the use of these toxic solvents. Because of the high regiospecificity of enzymes, enzy-

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